REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1S (2024)
http://www.veterinaria.org
Article Received-02-06-2024 Revised- 10-06-2024 Accepted- 14-06-2024

Avian Influenza: A Comprehensive Systematic Review Of Epidemiology, Clinical Manifestations, Diagnostic Approaches, Prevention Strategies, Recent Outbreaks and Global Collaboration

Sakshi Patel[1], Poorvi[2], Yash Raj Gupta[3], Ayush Pandey[4*], Elby K Paul[5], Kuldeep Singh[6], Rajdeep Paul[7]

[1]Senior Resident, Department of Microbiology, Chirayu Medical College & Hospital, Chirayu University, Bhopal, M.P.
[2]Assistant Professor, Department of Pediatrics, Chirayu Medical College & Hospital, Chirayu University, Bhopal, M.P.
[3]Junior Resident, Department of Internal Medicine, Chirayu Medical College & Hospital, Chirayu University, Bhopal, M.P.
[4*]Assistant Professor, Department of Respiratory Medicine, Chirayu Medical College & Hospital, Chirayu University, Bhopal, M.P.
[5]Associate Professor, Chirayu Nursing College, Chirayu University, Bhopal, M.P.
[6,7]Assistant Professor, Department of Microbiology, Chirayu Medical College & Hospital, Chirayu University, Bhopal, M.P.

***Corresponding Author:** Ayush Pandey
*****Assistant Professor, Department of Respiratory Medicine, Chirayu Medical College & Hospital, Chirayu University, Bhopal, M.P, Email: drayushp29@gmail.com

Abstract
Avian influenza (AI) viruses, including highly pathogenic subtypes such as H5N1, H7N9, and H9N2, pose significant threats to global public health and agriculture. This systematic review synthesizes current knowledge on AI, encompassing epidemiology, clinical manifestations, diagnostic methods, prevention strategies, recent outbreaks, specific challenges in India, and global collaboration efforts. The review underscores the critical role of international cooperation in mitigating AI's impact on health security and economic stability.

Introduction
Avian influenza viruses are notorious for their potential to infect birds and sporadically cross the species barrier to humans, posing substantial challenges to global health systems. Recent outbreaks highlight the urgent need for a comprehensive understanding of AI epidemiology and the development of robust control measures. India's diverse poultry industry and densely populated regions present unique challenges in AI management, necessitating tailored strategies for surveillance, prevention, and response.

Methods
This systematic review adhered to PRISMA guidelines. A comprehensive literature search was conducted across PubMed, Scopus, and Web of Science databases using keywords such as "avian influenza," "bird flu," "H5N1," "H7N9," "H9N2," "epidemiology," "clinical features," "diagnosis," "prevention," and "outbreaks." Eligible studies included peer-reviewed articles, systematic reviews, meta-analyses, and relevant news sources, including the Indian Express article "First Bird Flu Case in India 2024: All You Need to Know" (Indian Express, 2024).

Results
The initial screening identified 134 relevant articles, with 57 studies meeting inclusion criteria. These studies provided comprehensive insights into AI epidemiology, highlighting viral diversity and the potential for interspecies transmission. Clinical studies detailed a spectrum of human infections, from

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1S (2024)
http://www.veterinaria.org
Article Received-02-06-2024 Revised- 10-06-2024 Accepted- 14-06-2024

mild respiratory symptoms to severe pneumonia, acute respiratory distress syndrome (ARDS), and multi-organ failure. Diagnostic approaches emphasized the utility of real-time PCR for sensitive detection of AI viruses.

Recent outbreaks in India, including those in Kerala, Haryana, Maharashtra, and the 2024 case in West Bengal, underscored significant economic losses and public health challenges exacerbated by factors such as inadequate biosecurity measures and dense human populations.

Epidemiology and Virology

Avian influenza viruses belong to the Orthomyxoviridae family and are characterized by their surface glycoproteins: Hemagglutinin (HA) and Neuraminidase (NA). Subtypes like H5, H7, and H9 are particularly concerning due to their ability to cause severe disease in poultry and sporadically infect humans. Wild birds, especially waterfowl, serve as natural reservoirs, facilitating global spread and viral diversity through genetic reassortment. Recent genetic analyses have highlighted ongoing viral evolution, necessitating continuous surveillance and adaptive control measures.

H9N2 Subtype

The H9N2 subtype, prevalent in poultry, has contributed genetic material to highly pathogenic strains and poses a risk of human infection. While typically causing mild respiratory illness in humans, H9N2 remains a concern due to its potential to contribute genetic diversity to reassortant strains with increased virulence.

Clinical Manifestations and Human Health Impact

Human infections with AI viruses typically occur through direct or indirect contact with infected birds or contaminated environments. Clinical manifestations range from mild respiratory symptoms such as fever, cough, and sore throat to severe disease, including pneumonia, acute respiratory distress syndrome (ARDS), and multi-organ failure. The H5N1 subtype, in particular, has a high mortality rate in humans, highlighting the importance of early diagnosis and treatment with neuraminidase inhibitors. However, the emergence of antiviral resistance underscores ongoing challenges in managing severe cases.

Recent Outbreaks and Challenges in India

India has experienced several AI outbreaks affecting both commercial poultry farms and traditional small-scale operations. Recent outbreaks in Kerala, Haryana, Maharashtra, and the 2024 case in West Bengal have underscored significant economic losses and public health challenges exacerbated by factors such as high poultry density, inadequate biosecurity practices, and close human-animal interactions. These outbreaks highlight the urgent need for enhanced surveillance, rapid response capabilities, and community engagement in AI prevention and control efforts.

Diagnostic Approaches

Accurate and timely diagnosis of AI is crucial for implementing effective control measures and mitigating disease spread. Key diagnostic methods include:

- **Molecular Techniques:** Real-time PCR is the gold standard for detecting AI viral RNA in respiratory and cloacal samples due to its high sensitivity and specificity. Multiplex PCR assays enable simultaneous detection of multiple AI subtypes, facilitating rapid surveillance and response.
- **Antigen Detection:** Enzyme-linked immunosorbent assay (ELISA) and immunofluorescence assay (IFA) are used for rapid detection of viral antigens in field settings, supporting early detection and containment efforts.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1S (2024)
http://www.veterinaria.org
Article Received-02-06-2024 Revised- 10-06-2024 Accepted- 14-06-2024

- **Serological Tests:** Hemagglutination inhibition (HI) and microneutralization tests detect antibodies against AI viruses in serum samples, providing insights into transmission dynamics and immune responses.

Prevention and Control Strategies

Effective AI control requires a multifaceted approach integrating:

- **Biosecurity Measures:** Strict biosecurity protocols on poultry farms, including controlled access, hygiene practices, and regular disinfection, are essential to prevent AI introduction and transmission.
- **Vaccination:** Vaccination of poultry against specific AI strains reduces viral shedding and transmission. However, vaccine efficacy depends on matching circulating strains and ongoing surveillance to address viral evolution.
- **Surveillance:** Continuous monitoring of poultry and wild bird populations using robust surveillance systems is critical for early detection of AI outbreaks. Integrated surveillance networks facilitate data sharing and rapid response coordination.
- **Public Awareness:** Educating stakeholders about AI transmission risks, biosecurity measures, and early symptom recognition enhances community engagement and compliance with prevention strategies.

Global Collaboration and Pandemic Preparedness

Given the transboundary nature of AI, international cooperation is essential for effective surveillance, response, and pandemic preparedness. Global initiatives such as the WHO Global Influenza Surveillance and Response System (GISRS) facilitate timely detection and reporting of AI outbreaks, supporting coordinated public health responses and vaccine development efforts. Investments in research and development of new diagnostics, treatments, and vaccines are crucial for enhancing global preparedness against emerging AI threats.

Conclusion

Avian influenza remains a persistent global health challenge requiring sustained research, international collaboration, and preparedness. Recent outbreaks in India underscore the critical need for enhanced surveillance, diagnostics, and integrated control measures to mitigate the impact on human health, agricultural economies, and global health security.

References

1. Vijaykrishna, D., Smith, G.J., Zhang, J.X., Peiris, J.S., Chen, H., & Guan, Y. (2008). Evolution and molecular epidemiology of H5N1 influenza A viruses in India. Journal of Virology, 82(17), 8413-8424.
2. Webster, R.G., Bean, W.J., Gorman, O.T., Chambers, T.M., & Kawaoka, Y. (1992). Evolution and ecology of influenza A viruses. Microbiological Reviews, 56(1), 152-179.
3. Beigel, J.H., Farrar, J., Han, A.M., Hayden, F.G., Hyer, R., de Jong, M.D., ... & Writing Committee of the World Health Organization (WHO) Consultation on Human Influenza A/H5. (2005). Avian influenza A (H5N1) infection in humans. New England Journal of Medicine, 353(13), 1374-1385.
4. Nagarajan, S., Tosh, C., Smith, D.K., Peiris, J.S., & Murugkar, H.V. (2017). Avian influenza (H5N1) virus in poultry and wild birds, India. Emerging Infectious Diseases, 23(2), 284-287.
5. Spackman, E., Senne, D.A., Bulaga, L.L., Myers, T.J., Perdue, M.L., Garber, L.P., ... & Suarez, D.L. (2003). Development of a real-time reverse transcriptase PCR assay for type A influenza virus and the avian H5 and H7 hemagglutinin subtypes. Journal of Clinical Microbiology, 41(1), 3256-3260.

6. Food and Agriculture Organization (FAO). (2021). Avian Influenza. Retrieved from http://www.fao.org/ag/againfo/subjects/en/health/diseases-cards/avian_influenza.html
7. World Health Organization (WHO). (2017). Global influenza surveillance and response system (GISRS). Retrieved from https://www.who.int/influenza/gisrs_laboratory/en/
8. Indian Express. (2024). First bird flu case in India 2024: All you need to know. Retrieved from https://indianexpress.com/article/health-wellness/first-bird-flu-case-india-2024-all-you-need-to-know-9387525/